0.1 Supersymmetery Search

The Standard Model of particle physics is a theory of electromagnetic, weak and strong interactions that has been successfully tested by experiment. Supersymmetery (SUSY) is an extension to the Standard Model that offers compelling solutions to problems that arise in that theory. For example, the Standard Model includes corrections to the Higgs particle mass that contain quadratically divergent terms. These divergences can be made to cancel naturally with the introduction of supersymmetery. For this cancellation to occur the theory predicts that every Standard Model particle must have a supersymmeteric partner. Most SUSY models assume that the number of supersymmeteric particles in an interaction is conserved, and therefore establish a new conserved quantity called 'R-parity' that accounts for this. There is no *apriori* reason, however, to assume that R-Parity is conserved.

We will search for the R-parity violating decay of the heavy neutral sneutrino, the supersymmeteric partner of the neutrino, into leptons of different flavor. A depiction of the process is shown in Figure 1.

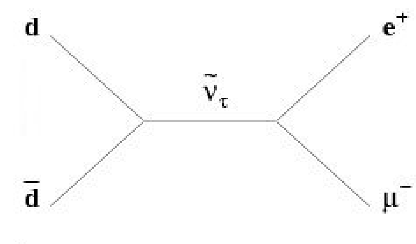

Figure 1: A Feynman diagram for the R-parity violating production and decay of the sneutrino

The production of the sneutrino from protons and anti-protons and its decay into leptons are R-parity violating. Neither interaction conserves supersymmeteric particle number. The final state for the process includes two high momentum leptons of different flavor, a signature that will allow us to suppress most Standard Model backgrounds. This signature is shared by a range of new physics in addition to SUSY, such as decays of horizontal gauge bosons and the Z'. Our analysis may be easily extended to these in the future.

The sneutrino decay analysis was originally presented in RunI[1]. The larger integrated luminosity and the increase in acceptance from detector improvements in RunII will yield larger statistics. We hope to further increase acceptance by developing our analysis techniques beyond those used in RunI. We are considering, for example, the adoption of event selection criteria used in CDF's RunII top-dilepton analysis. Traditional dilepton analyses require candidate events to contain two identified leptons. CDF's recent top-dilepton analysis showed that a substantial improvement in acceptance may be gained (while maintaining acceptable background levels) by loosening the lepton identification requirements on one of the candidate leptons (see section **??**). In addition, we expect to increase acceptance by using detector information on forward electrons and hadronically decaying taus.

We could have incorporated improvements to the RunI search in our analysis immediately but instead elected to keep our initial analysis framework much like that used in RunI. Doing so allows gains in signal acceptance that result from modifications to the RunI search to be more easily quantified. Currently, we have applied the event selection criteria used in the RunI analysis to RunII Monte Carlo samples of signal and relevant Standard Model backgrounds. Figure 2 shows the invariant mass distributions of the three most significant Standard Model backgrounds to the sneutrino decay (Drell-Yan, WW and top) after the application of analysis cuts. The acceptances determined for these samples, in addition to that for a Monte Carlo signal sample, agree well with the corresponding values quoted in RunI.

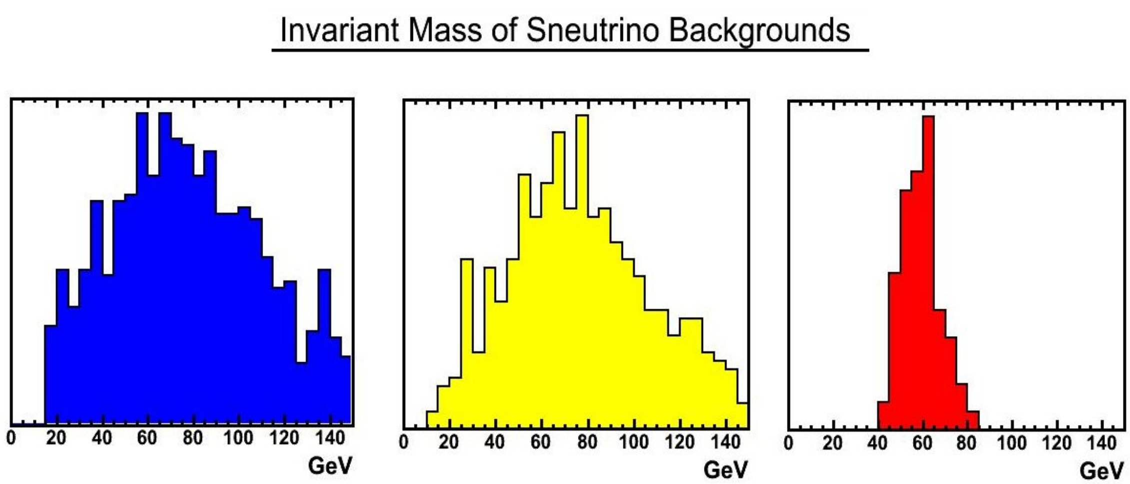

Figure 2: Invariant mass distributions for sneutrino backgrounds with an arbitrary vertical scale. Blue: top, Yellow: WW and Red: Drell-Yan

The search will allow us to set an upper limit on the decay cross-section of the sneutrino into leptons and provide best estimates of couplings in the R-parity violating SUSY model. The theoretical cross section for sneutrino decay into leptons is on order 10pb, leaving open the possibility of a discovery. This work is being performed by graduate student Kristian Hahn in fulfillment of his thesis requirements, with guidance from Prof. Nigel Lockyer and Dr. Peter Wittich.

References

[1] CDF Collaboration, D. Acosta *et al.*, Phys. Rev. Lett. **91**, 171602 (2003).